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MA TUNG-I'S METHOD OF FERTILE SOIL FORMATION

By Hsiung I

- COMMUNIST CHINA -

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[Following is the translation of an article in Kuang-ming Jih-pao, Peiping, 21 November 1960, page 1.]

I Chin-chu, an assistant research worker at the Kiangsu Sub-Institute of the China Agricultural Institute, made a long stay in the rural area. Not only did he contribute to increasing the production of cotton but he also established the concept that scientific research must be based on practical production. Now, whenever he talks about the memories of his 6-year stay in the rural area, during which he performed scientific research, I Chin-chu becomes excited and says, "It was a correct thing I did to stay in the rural area."

When I Chin-chu for the first time led a group of workers into the rural area in T'ai-tsang Hsien, he doubted that if he were to make a long stay in the rural areas would he be able to attain achievements in the field of science. But, very soon practical production gave him many scientific problems. In 1954, the rain at the time of the summer solstice in T'ai-tsang Hsien lasted very long. One of the bases where this group was working was the Hsin-i Agricultural Cooperative. Here, the cotton seedlings were dying from a serious disease. The head of the cooperative asked this group of research workers to help overcome this difficulty. I Chin-chu suggested digging ditches to drain off the water and to isolate the diseased seedlings. But these methods failed. Confronted by this urgent problem that he could not solve, he began to realize that scientific research without contact with reality could not make progress. After this, he became modest and began to learn from the old farmers. After the group made careful investigations and research, a prevention method was finally discovered. This became the basic measure to protect cotton seedlings in this area. After this production problem was solved, he became very happy.

Before he went to the rural areas he always believed that the harvest from single-crop cotton would be greater than that from two crops, one being cotton and the other grain. However, the region of T'ai-tsang Hsien always was a dual-crop district -- cotton and grain. The members of the cooperative told him, "Our cotton growing area also strives for self-sufficiency in grain; we cannot rely solely on the supply of grain from the grain growing areas." I Chin-chu was awakened to the fact that the problem must be viewed from all-out production.

In order to seek out the reason for increased production of both cotton and wheat, I Chin-chu visited two labor models workers in Pao-shan Hsien, Shen Hu-tung and Chiang Lao-san. They suggested that cotton be planted in the wheat fields. In this way the wheat would give protection to the cotton seedlings and give them warmth, thereby increasing the rate of growth of the seedlings. Thus, cotton production would be increased. These suggestions were a great awakening for I Chin-chu. After two more years of studies with his workers, he was able to summarize the basic production experiences prevailing in this region, where the two crops of cotton and wheat were produced every year. He also made theoretical improvements, which in turn increased production in the region.

For a long time, I Chin-chu labored and lived together with the masses and established a profound friendship with them. He contributed all his energy to scientific research in the service of agricultural production. His spirit was greatly praised by the cadres and the masses in the region.

MA T'UNG-I'S METHOD OF FERTILE SOIL FORMATION

[Following is the translation of an article by Hsiung I, Director of the Soil and Water Preservation Research Institute, Chinese Academy of Sciences, in Kuang-ming Jih-pao, Peiping, 21 Nov 1960, page 2.]

The important task confronting us today in agriculture is how to raise rapidly the production of agricultural crops, especially of grain. In order to fulfill this task, there must be an all-out implementation of the "eight-word charter" in agriculture and the full application of the effect of man's subjective capacity in utilizing and transforming nature. The task of soil science is to attain the rapid formation of fertile soil; constantly to raise the strength of fertile soil; and to transform poor soil into fertile soil, low production into high production, and high production into still higher production. China's toiling peasants have very rich experiences in formulating fertile soil. The nationally famous model agricultural worker, Comrade Ma T'ung-i, on the basis of deep-cultivation studies, created the concept of "fusing soil with fertilizer." He believes that the fusion of soil with fertilizer is the basis for the formation of fertile soil and the development of deep and careful cultivation. Today, when there is an all-Party and all-peoples movement for the promotion of agriculture and grain production, timely emphasis on the question of fusing soil and fertilizer, on summarizing and studying, not only increases the prevailing agricultural production but also has important meaning for the development of China's soil science.

What Is Fertile Soil

In order to understand what fertile soil is, one must first understand what the strength of fertile soil is and how soil possess this strength. Here again one must understand what soil is. As regards what soil is there exist two different ideas. The soil specialists of the capitalist school believe that the more the soil is used for cultivation, the poorer it will become and the lesser will be its strength. This conclusion is drawn from two factors, one being the nature of the reactionary class and the other the metaphysically erroneous concept, both of which bring about this inevitable result. The capitalist soil specialists regard soil as broken bits of rock, but they neglect the important effect of organic and biological matter. They regard soil as

a mere storage place of plant nutrition, but they do not understand that soil itself possesses the capacity of adjusting the various types of essentials of life needed by the plants. Because they regard soil as a static, dead matter, they mistakenly think that man can do nothing to improve soil, so the more the soil is used for cultivation, the poorer it will become. In accordance with their spiritual metaphysical concept, they even create the unscientific "law of diminishing strength in fertile soil" and advocate the reactionary "Essay on [the Principles of] Population," by Thomas Robert Malthus.

The dialectic materialistic concept regards soil not as static, but as mobile and active and possible of being transformed; not as isolated, but as closely related to its surroundings. In order to study the law of soil development, one must first analyze the various internal contradictions in soil, of which there are many. The most important contradiction is the composition and decomposition of organic matter. This includes the action of microbes. This is the prime contradiction differentiating soil from weather-worn bits from rock, and it is also the common contradiction that exists in all soil. If any soil does not possess this contradictory unity, there is no strength of fertile soil in it, and it can not be called soil. When one understands soil correctly, analyzes the internal and external contradictions, seeks out the principal contradiction, he can then conscientiously develop his capacity and, in accordance with his own needs, can improve the soil, constantly raise the strength of fertile soil and transform poor soil into fertile soil.

When one understands soil correctly and knows clearly what important meaning there is in the composition and decomposition of organic matter in relation to the formation of soil, he can attain an all-out understanding of what the "strength of fertile soil" is. The strength of fertile soil is the comprehensive manifestation of the various types of soil characteristics. This strength is the combination of moisture, nutrition and other essentials of life that are provided by soil for plant growth and of the capacity to adjust these essentials of life. A study of this supply and adjustment discloses more fully the special nature of soil and explains thoroughly the important meaning of composition and decomposition of organic matter in relation to the strength of fertile soil. The strength of fertile soil is a relatively broad concept. Any soil has this capacity, but weather-worn pieces of rock do not possess this capacity. Otherwise, fertile strength would not only be the nature of soil, but common to both soil and rock bits, hence there would be no difference between the two. In the past, it was assumed that the strength of fertile soil, at best, was the soil's ability to provide moisture and nutrition to satisfy plant needs. The idea limits strength only to fertile soil but not as the nature of any soil. As a matter of fact, no matter if the soil is fertile or poor, it possesses this strength. Because soil has the ability to provide moisture, nutrition and other essentials of life and to adjust them, some soil may have a good ability while others a poor one, or some may have a

high ability while others a low one; thus, soils are divided into fertile and poor. Fertile soil can provide plants at the various stages of their growth with timely and adequate amounts of moisture, nutrition and other essentials of life, and it also possesses an excellent ability to adjust these life essentials, permitting the plants to eat fully, drink adequately, and live comfortably. On the other hand, poor soil also can provide the plants at the various stages of their growth with moisture, nutrition and the other essentials, but it does not guarantee that these supplies are on time and adequate to satisfy the plants' needs, nor can it properly adjust these essentials. Poor soil can only permit the plants to eat, drink and live, but the plants cannot eat fully, drink adequately and live comfortably.

The above facts are the basic distinguishing features between fertile soil and poor soil. Under different conditions, fertile and poor soils have special manifestations. In each type of soil some is fertile and some is poor. Any of the various types of soil can be transformed into fertile soil, but the fertile and the poor in the various types are not the same. Because the various types of crops are not the same, the standards for soil fertility or poorness also are not the same. In addition, the environment is different and the cultivation and control methods are different; as a result, the function of fertile soil in agricultural production is different. When fertile soil undergoes drought or flood, it loses its strength. If we are to have fertile soil, we must have deep and careful cultivation in order to make full use of it.

Fertile soil has many merits. It is loose and soft. It gives good root development. Generally, its porosity is over 50%, and there are more lumps with a loaminess of 0.25-10 millimeters, which form an excellent soil structure. Therefore, the soil has good water storage and good air circulation. Water penetrates through it rapidly and there is very little evaporation. In winter the frost does not go very deep. Because fertile soil has a greater water-storage capacity, it has greater drought resistance. Fertile soil can adjust soil temperature better. The higher the degree of fertility in soil, the smaller becomes the difference between the soil temperature during the day and at night. In winter the soil temperature is relatively higher, while in the summer it is relatively lower. When the soil temperature rises in the winter, it is advantageous for the root growth of wheat and gives greater safety to wheat against winter cold. When the soil temperature decreases in the summer, it also accelerates the growth of the roots. Comrade Chang Shuan-ching of the Ta-ch'iang-chou People's Commune in Ch'angko Hsien, used a pane of glass stuck into the soil to observe the root growth of wheat during the winter. The roots grew two inches longer every five days in fertile soil, but they grew very slowly or even stopped growing in less fertile soil.

In fertile soil, the amount of plant nutrition is relatively higher. There is more organic matter and it is richer in nitrogen, phosphorus, and potassium. Fertile soil not only contains more nutrients,

but its nutrients have a high efficiency and can supply plant growth with timely needs. Fertile soil has a greater absorbing capacity and a stronger preservation ability. The more fertile the soil, the less fixed phosphorous acid it has; thus, the function of phosphorus becomes greater.

In fertile soil, the great increase in the quantity of carbon dioxide means that the microbes are very active. According to preliminary studies, fertile soil has more decomposed fiber microbes. The organic nitrogen in stalks and animal fertilizers can be released more readily. The amount of nitro-microbes, ammonium microbes and phosphorus microbes will correspondingly increase as the degree of fertility in the soil increases. In fertile soil, the various types of bacilli are very active, which accelerate the process of decomposition and composition of the organic matter in the soil, so that soil and fertilizers can be fused readily.

The more fertile the soil becomes, the greater amount of decayed plant matter it has and the more decayed plant matter goes into the small particles of soil. In fertile soil, not only is the amount of decayed plant matter high, but its quality is also very good. The decayed plant matter in fertile soil contains a relatively large amount of "hu-min" acid. The content ratio between "hu-min" acid and fu-fei" acid is also relatively high. "Hu-min" acid has a higher adhesive function and a greater absorbing capacity.

The Fusing of Soil and Fertilizer

How can poor soil be transformed into fertile soil? As regards the transformation of the strength of fertile soil, Comrade Ma T'ung-i created the law of transforming dead soil into live soil and transforming live soil into "oil soil." By oil soil, Comrade Ma T'ung-i refers to fertile soil. Dead soil is the solid layer beneath the surface of the soil that has never been touched by sunshine. After it has been turned up, shined on by the sun, soaked with water, frozen by frost, and loosened into clots of soil, the dead soil can be transformed into live soil. After careful cultivation, the application of fertilizer, and the fusion of soil with the fertilizer, live soil can be transformed into oil soil. Deep cultivation can transform dead soil into live soil and if we want to transform live soil into oil soil, we must rely on the use of fertilizer. The application of organic fertilizer not only adds nutrients to the soil to meet the growth needs of the crops, but it also improves the function of the soil.

The principal reason that soil and fertilizer can be fused and penetrated lies in the fact that both possess very active adhesive bodies. The mineral adhesive bodies in soil principally are very small adhesive granules. The adhesive bodies in organic fertilizer principally are decayed plant matter. When the decayed plant matter and the adhesive granules fuse together, they can form loose and stable solid matter. When there is no fertilizer, or very little fertilizer, under conditions

where no fusion between soil and fertilizer can be attained, the soil generally has a single-granular appearance (the soil granules do not adhere together) or a compound-granular appearance (the granules of soil join together), or it has a bad soil structure and its water-storage and fertilizer-preservation capacities do not function properly. If organic fertilizer is added to the soil, and after the soil and fertilizer are fused together, the decayed plant matter in the fertilizer joins together with the soil granules -- some loosely joined and some solidly joined; some of the decayed plant matter even penetrates into the crystalized layer of mineral matter. As time passes and water and heat conditions change, the decayed plant matter and the adhesive granules join together more solidly, the adhesive film becomes thicker, and the good loose structure becomes more stable. When the fusion between soil and fertilizer continues constantly, there is a gradual transformation taking place in the soil, adjusting the moisture, nutrients and other essentials of life to meet the needs of plant growth. This capacity also becomes stronger.

Then, is it so that the more thorough the fusion of soil and fertilizer, the more fertile the soil becomes? Again, this is not the complete picture. The fusion of soil and fertilizer is the basis of fertile soil formation, but it is not the only condition. In order to formulate fertile soil, in addition to attaining fusion between soil and fertilizer, we must pay attention to the degree of fertilization, which includes the amount of fertilizer used, its quality and its degree of ripeness. If the amount of fertilizer is too small, though the fusion between soil and fertilizers may be very good, the soil so formulated is still not fertile soil. If a large amount of fertilizer is applied, but the fusion between soil and fertilizer is not good, the soil so formulated is still not fertile soil. Therefore, the degree of fertilization and the fusion between soil and fertilizer are two important elements in the formation of fertile soil. In general, in the formation of fertile soil, attention is given only to the application of fertilizers and not much attention to the fusion of soil and fertilizer. Therefore, fusion of soil and fertilizer becomes the key problem in the success of formulating fertile soil.

As regards whether the fusion of soil and fertilizer has been thorough or not, the people of the Meng-p'ai-ts'un in Ch'ang-ko Hsien have a very apt saying: soil to which no fertilizer or very little fertilizer has been applied, they call "white-face land" or "great white-face"; soil in which the fertilizer has not thoroughly decayed, minutely broken up, or been evenly applied, so that the soil and fertilizer are not properly fused, with one patch yellow and another patch black, with the soil remaining soil and the fertilizer fertilizer, the people call "motley-dog face." Because there are different types of fertilizers and different degrees of ripeness, the appearance of "motley dog-face" are also different. Some run in stripes, some in round spots, and some in layers. Because the degree of fusion of soil and fertilizer differs in various soils, the condition of crop growth

also differs. In "white-face land," the roots of wheat generally cluster at a depth of 20 millimeters. They are shallow and can not be fully developed. In "motley-dog-face" soil, the roots of the wheat are coarse and short, growing in a cluster in the areas where there is fertilizer. In soil where there is plenty of fertilizer and where the fusion of soil and fertilizer is good, the wheat roots grow in a layer of soil 50-millimeters deep and the roots are fully developed. With fertile soil, sprouting time is 8-10 days earlier than in both the "white-face land" and the "motley-dog-face" soil, and the leaf growing time is about five days earlier. With high effective sprouting, yields are also relatively higher. Practical experience has shown that when similar fertilizers are applied but the degree of fusion is different, the crop harvest is different, and sometimes this difference is very great. This fact clearly shows that in applying fertilizer, special attention must be given to the fusion of soil with the fertilizer, otherwise the function of the fertilizer cannot be fully enjoyed and it even may harm the crop.

The principle of fusion of soil and fertilizer is a summarization from the production practices of China's mass of peasants. It fully reflects the important meaning of the application of organic fertilizer and the deep and careful cultivation in relation to the formation of fertile soil. Summarizing the principle of fusing soil with fertilizer, not only expands the inner meaning of the strength of fertile soil, but also tells us that in the future, in the work of formulating fertile soil, we must utilize comprehensive measures in order to promote man's subjective capacity. The labors assigned to the improvement of soil must coordinate plant nutrition with soil improvement activities. In order to investigate the nature of fusion of soil and fertilizer, we must make a deep study of the fusing of the organic and inorganic adhesive bodies and its relation to the increased strength of fertile soil and the adjusting of the nutrients and moisture needed by the plants. Accordingly, we must promote China's research work in the fields of soil chemistry, bio-chemistry, and the other scientific disciplines. The development of these activities undoubtedly will enable China's soil science to enter into a new stage. From practical production, new scientific theories will develop China's soil science.

How to Formulate Fertile Soil

In the above, it has been said that there are two important elements in the formation of fertile soil. One is the degree of fertilization and the other is the fusion of soil and fertilizer. But, if we neglect cultivation and irrigation, we still cannot formulate fertile soil.

In order rapidly to transform soil into fertile soil, there must be quantity application of fertilizer, continuous application of fertilizer, and yearly application of fertilizer. If the fertilizer is not applied yearly, the strength of the fertile soil cannot be preserved and it will even degenerate into poor soil. Comrade Ma T'ung-i has correctly

said, "After three years of cultivation, land becomes fertile land, and after one vacant year, the land becomes barren." This exemplifies the important meaning of continuous application of fertilizer.

The quality of fertilizer is very important to the formation of fertile soil. Of primary importance is the use of decayed and ripe fertilizers. It is best to use the combination of human waste, hog manure, and green manure. It supplies nutrition, improves the soil, and raises the strength of the fertile soil. We once analyzed the fertilizers used by the peasants of Meng-p'ai-ts'un in Ch'ang-ko Hsieh (Honan Province) and tested the various types of fertilizers to find out their effect on the improvement of soil. Preliminary results show that manures from cattle pens and hog farms not only have a very high organic-matter and nitrogen content, but also have greater effect on soil improvement.

Comrade Ma T'ung-i has five words by which the degree of decomposition and ripeness in fertilizers can be ascertained: black, decayed, stink, broken, and even. By black and decayed, he means that the organic matter in the fertilizers is so decomposed that it appears to be black, decayed plant matter. This matter is most effective in the fusion of soil and fertilizer and also is the most active. The stink indicates that all the proteins are thoroughly decomposed and that nitrogen is released. By broken and even, he means that the soil and grass added into the formation of fertilizers must be finely broken and evenly blended. The peasants often say, "After stirring three times, manure becomes ripe; if it is not black, decayed, stinking, broken, and even, it should not be applied to the soil." This has a very clear meaning.

In addition, the method of applying fertilizer is very important. For basic fertilizer, the amount must be large. It must be applied layer by layer at a definite ratio, otherwise it will not be evenly blended. If a small amount of basic fertilizer is used, it should be minutely broken and evenly spread on the ground before cultivation takes place. Then, it should be ploughed under so that it will be fused with the soil.

In follow-up fertilization, the following principles should be followed: coarse fertilizer must be carefully applied, solid fertilizer must be applied in liquid form, fine fertilizer must be skillfully applied, and human waste should be applied along with water. Green manure and animal manure are coarse fertilizers. If they were used for follow-up fertilization, they should be carefully broken up and evenly applied to the ground so that they will fuse with the soil. Soluable solid fertilizer should be dissolved in water and applied to the soil in liquid form. Fine fertilizer can be applied by drilling, in rows, in holes, or in rings so as to avoid waste. Human waste must be applied along with water to prevent the plants from being injured and to accelerate the fusion of soil and fertilizer.

Deep cultivation is a basic measure for fine and careful cultivation. For heavy fertilization, the land must be under deep cultivation to permit fertilizer and soil to be mixed together evenly, actuating the

process of fusion and hastening the transformation of live soil into oil soil. Under conditions of shallow cultivation, heavy fertilization not only produces "motley-dog-face" soil but also easily injures the plants. Fertilization under deep cultivation must be combined with careful land treatment, such as deep, fine, even, and thorough harrowing, so that the surface will be even, with very few lumps. This will be favorable to root growth and will promote the fusion of soil and fertilizer. Harrowing is an important measure for moisture preservation. If the land is well harrowed, wet soil will be discovered at two-fingers' depth from the surface. If a grinding process is applied after harrowing, the effect of moisture preservation will be increased. Comrade Ma T'ung-i often says, "There is no fear that the plants will not grow, but the only fear that we have not worked enough." He again says, "The land is the same, the management may be different, and different cultivation gets different yields." These sayings fully tell the meaning of fine and careful cultivation.

Reasonable crop rotation also has a good effect on the formation of fertile soil. The various crops have different methods of cultivation, fertilization, and management, which are mutually helpful to one another. Autumn and spring crops can be planted by deep cultivation; corn is grown in broad rows, which need medium cultivation. Industrial crops and vegetables need heavy fertilization and careful management; therefore, a reasonable rotation system will hasten the fusion of soil and fertilizer and raise the strength of the fertile soil.

The processes of decomposition, ripening and dissolution of fertilizer and the fusion of soil and fertilizer all rely on water. After cultivation, the ground should be sprayed with water to make the soil solid and to prevent the roots from being too loose. In treating the land, one must judge the condition of moisture preservation. The best time for treating the land is half-way between dry and wet, because then ploughing will be easy, there will be no lumps and the soil will be easily broken. When the preserved moisture is too heavy, the soil must be sun-dried after ploughing to reduce some of the moisture. Then a harrowing process will eliminate the lumps. During the growth of the plants, attention must be given to supply adequate water by frequent, careful, even, and thorough spraying so as to preserve a regular amount of moisture in the soil. This not only supplies the needs for plant growth but also actuates the fusion of soil and fertilizer. In addition, moisture can adjust soil temperature. Winter irrigation raises the soil temperature while summer irrigation lowers soil temperature. Moisture also has the effect of promoting the activities of the microbes.

The above are effective measures which, principally, have the fusion of soil and fertilizer as their main goal. This is the correct treatment of the relation between soil and fertilizer. Soil is the basis, fertilizer constitutes the premise, and water is the guarantee. The fusion of soil and fertilizer is the basis for the formation of fertile soil. It is a systematic summarization and profound study of the principle and measures for the fusion of soil and fertilizer. It not only can actuate agricultural production, but also develop China's original soil science.

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